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David Bloor—*The Enigma of the Airfoil: Rival Theories in Aerodynamics, 1909–1930*, The University of Chicago Press, Chicago, London (2011) ISBN 978-0-226-06095-8, and Osvaldo Novais de Oliveira Jr and Rui Jorge Sintra, eds.—*A Física a Serviço da Sociedade*, IFSC/USP, São Carlos (2014) ISBN 978-85-61958-03-9

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A previous review published by the Brazilian Journal of Physics [(44, pp. 125–127 (2014)] examined two attempts, by physicists, to bridge the communication gap separating humanists and social scientists from hard scientists. I now try to review two books that deal with the intellectual wall between engineers and physicists. Engineering and Physics being nearly contiguous disciplines, it is difficult to understand why a wall should arise. One of the books addresses this important question. The other shows that cooperation between the two areas should be a priority, so beneficial is it to society.

The first book is “The Enigma of the Airfoil”, by David Bloor. It describes the struggle that took place between 1909 and 1930 between British mathematical physicists, who were wranglers on the University of Cambridge Mathematical Tripos exam, and German engineers concerning rival theories of aerodynamics. German theoretical physicists — Albert Einstein, for one—were drawn into the struggle. Looking back on the rapid progress of aeronautical industry in the following years, we would think that the debate was settled well before the war. Nonetheless, the last example in the book, which depicts an alleged dispute between Richard Feynman and NASA engineers, indicates that the struggle persists, in milder form. The second book, by Osvaldo Novais de Oliveira Junior and Rui Jorge Sintra, titled “A Física a Serviço da Sociedade” shows how a group of physicists and engineers joined forces to solve multidisciplinary problems in São Carlos Brazil.

David Bloor’s book is too rich for a simple review. It would take many pages to even cover the skin of the problem, but let me try to describe it. At its heart are two forces that appear when an airfoil is pushed through the air. One is the drag, which opposes movement. The other is an upward force, the lift. To minimize the former while maximizing the latter, aircraft designers rely on fluid dynamics.

Airplanes were of course unknown at the end of the nineteenth Century, when our story begins, but fluid dynamics already had a long history. In a nut shell, the theory at that time consisted of the Navier-Stokes equations, which described real fluids, but could not be solved, and Euler’s theory, an elegant formalism that covered only ideal fluids. In the steady state, it had long been known, an ideal fluid neither drags nor lifts bodies moving through it. It was then discovered, by W. Kutta, N. Joukowski, F. W. Lanchester, and other engineers, that if the air movement around the airfoil were the combination of a steady flow with a circulation, Euler’s theory would be sufficient to determine the lift and the drag. The mathematical physicists turned their noses up at this finding, because it lacked first-principles justification, but in 1904 Ludwig Prandtl put forward the concepts of boundary layer and flow separation to explain how the drag and lift forces could be extracted from the mathematical treatment of an ideal fluid.

Prandtl was a professor of fluid mechanics at a technische hochschule. Until the end of the nineteenth Century, the German schools of engineering were barred from granting doctoral degrees. Thanks to the help of highly influential people, such as the mathematician Felix Klein, who had connections with the General-Staff Officers (page 254), the technische hochschulen overcame that limitation in 1899, “in a measure backed by the Kaiser Wilhelm II”. The Technische Universität Münchenit was granted the right to award

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doctorates in 1901 (page 204), and Prandtl was one of the first to receive their PhD.

Besides providing much food for our thoughts, the book is very instructive. We learn that the physicists' approach to teaching fluid mechanics is incorrect [for more on this, see Holger Babinsky, How do wings work, *Physics Education* 38(6) 497–503(2003)].

We also learn that even the greatest physicists are vulnerable to blunder when pontificating outside their specialties. Einstein's attempt to explain lift is detailed in a section entitled Einstein's folly. At the time, his explanation attracted attention. Trusting his wisdom, the aircraft makers LVG and Merkur built an airplane with the wing profile designed by the Father of Relativity. The technical manager for LGV, Paul Ehrhardt, acting as test pilot, barely managed to take the machine off the ground, was relieved to bring it down and declared that the plane flew like a pregnant duck (page 300). Ehrhardt's appraisal may surprise readers with a background in Biology, but this only goes to show how extravagant hyperboles could be, 100 years ago.

Almost 200 pages later, on p. 494, Bloor describes Richard Feynman's celebrated explanation of the Challenger Space Shuttle accident in the following terms: "Feynman's failure to take into account the complex relativities of the actual decision process did an injustice to the persons who had the responsibility for the launch and the death of the crew. The oversimplification contributed more to public misunderstanding of science than to its understanding".

In this reviewer's opinion, Bloor may have overlooked the pressures upon the Nobel laureate as well. A more revealing statement of Feynman's view of the cooperation between Engineering and Physics is found in "The Feynman Lectures on Physics", Chapter 44, Vol. I: "In fact, the science of thermodynamics began with an analysis, by the great engineer Sadi Carnot of the problem of how to build the best and most efficient engine, and this constitutes one of the few famous cases in which engineering has contributed to fundamental physical theory. Another example that comes to mind is the more recent analysis of information theory by Claude Shannon." He could of course have added aerodynamics to his short list.

The second book, "A Física a Serviço da Sociedade", is a must read for all Brazilian physicists. The first great thing about the book is that for the first time, as far as I know, members of a distinguished Institute, funded by the (State) government, recognize that they are not merely employees of the people. They implicitly recognize owing their entire education to the people and that they are, therefore, public servants and should strive to help those who helped them.

More to the point of this review, the book describes in great detail the effort of the so-called CEPIDS, funded by the FAPESP, and the INCT, funded by the FAPESP and the Ministério de Ciência e Tecnologia do Brasil, respectively, to promote research in multidisciplinary areas. Those of my colleagues who had the patience to follow this review know how difficult this task is. Multidisciplinary efforts have been attempted and are being attempted in other countries; difficulties have sprung up everywhere. The Brazilian experiment in interdisciplinary physics, engineering included, is a success by anyone's measure.

After the Introduction, the reader finds, in Chapter 2, five essays on the future of physics, which target physicists, not the general public. Each essay describes the future of Physics in the author's view. Here, the text treads on thin ice. Those who disagree are referred to the series of articles by Freeman Dyson, beginning with the masterpiece titled "The Future of Physics", *Physics Today*, September 1970, pages 23–28.

Chapter 3 describes the effort of the Institute (IFSC-USP) to develop interdisciplinary areas. This very good chapter contains a viable template for other institutions that want to engage in multidisciplinary work. The rest of the book describes, in very readable language, advances with technological applications or potential technological applications in six different areas: Fundamentals of Physics, Materials and Nanotechnology, Energy and Environmental Problems, Computational Physics, Physics and Bio-molecules and Health.

The next chapter describes several products in pre-industrial stage that resulted from research at the IFSC-USP, and the last one recapitulates the purpose of the book, which in this reviewer's opinion was very satisfactorily achieved.

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